REMARKS

Administrative Overview

Applicants hereby amend claim 17 as indicated in the Listing of Claims set forth above. Support for this amendment can be found in the specification as filed, and at least at paragraphs [0009]-[0014]. Applicants hereby add new claims 19-21. Support for these claims can be found in the specification as filed, and at least at paragraphs [0009]-[0014], [0025], [0028], [0030], and [0035]-[0041], and in FIGS. 1-3. Applicants hereby cancel claim 18. No new matter is added thereby. Claims 1-17 and 19-21 are now pending in this application and are presented for reconsideration.

In the Office action mailed on April 4, 2007, claim 18 was rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement.

Claims 1-3 and 5-11 were rejected under 35 U.S.C. §103(a) as unpatentable over Berthold *et al.* (Sensors and Actuators 82, 224-228, (2000)) (hereinafter "Berthold") in view of International Application No. PCT/JP03/00570 to Fukushima *et al.* (hereinafter "Fukushima").

Claim 4 was rejected under 35 U.S.C. §103(a) as unpatentable over Berthold and Fukushima, further in view of Sarro (Sensors and Actuators A: Physical, 82(1), pp. 210-218, (2000)) (hereinafter "Sarro").

Claim 12 was rejected under 35 U.S.C. §103(a) as unpatentable over Berthold and Fukushima, further in view of Applicants disclosure (Paragraph [0026]).

Claims 13, 14, 15, and 17 were rejected under 35 U.S.C. §103(a) as unpatentable over Berthold and Fukushima, further in view of the combined teachings of U.S. Patent No. 6,550,337 to Wagner *et al.* (hereinafter "Wagner"), Sarro, Schmidt (Proceedings of the IEEE, 86(6), 1575-1585, (1998)) (hereinafter "Schmidt"), and Lee *et al.* (J. Vac. Sci. Tech. B 12(6), 3425-3430, (1994)) (hereinafter "Lee").

Finally, claim 16 was rejected under 35 U.S.C. §103(a) as unpatentable over Berthold and Fukushima.

For the reasons that follow, Applicants respectfully submit that the claims, as amended, are patentable over these references. Therefore, Applicants request reconsideration and withdrawal of the rejections.

Claim Rejection Under 35 U.S.C. § 112

Claim 18 was rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Applicants hereby cancel claim 18, thereby rendering the rejection moot.

Claim Rejections Under 35 U.S.C. § 103(a)

Claims 1-3 and 5-11 were rejected as unpatentable over Berthold in view of Fukushima.

Applicants' invention, as recited in independent claim 1, anodically bonds a glass layer directly to "*a first substrate having an elastic modulus greater than about 150 gigaPascals.*" In contrast, Berthold appears to teach bonding a glass wafer to a composite structure comprised of at least two materials: another glass wafer with a thin film of a second material, such as silicon carbide, coated thereon. As explained below, the "effective" elastic modulus of a composite layered material is related to the elastic modulus and thickness of each material. As such, the elastic modulus of the composite wafer structure of Berthold will, as set forth below, be substantially lower than the "150 gigaPascals" recited in claim 1.

As described in "*Formulas for Stress and Strain*," by R. J. Roark and W. Young (New York: McGraw-Hill, 5th Ed., 1975, pp. 112-113), attached hereto as Appendix I, the "effective" elastic modulus of a composite structure comprising two materials of differing elastic modulus is related to the relevant quantities of each material in the structure. Moreover, as explained further below, the equations for calculating the effective elastic modulus of a composite structure that are shown in Appendix I may be simplified to provide, as a first-order approximation, a linear relationship based on the thickness of each material.

More specifically, experimental results showing the substantially linear relationship between the elastic modulus of a composite wafer structure and the thicknesses of its materials are provided in U.S. Patent No. 7,165,463 to Liu et al. (hereinafter "Liu"), attached hereto as Appendix II. FIG. 9, and col. 10, line 40 though col. 11, line 18 of Liu, for example, show experimental results for the elastic modulus (E^*_s) of a composite structure that includes a silicon wafer and a thin layer of titanium nitride (TiN) coated thereon. As can be seen in FIG. 9, as the dimensionless thickness T_c of the Titanium Nitride coating is reduced, the resulting elastic modulus E^*_s of the composite material is linearly reduced. Liu further states, at col. 7, lines 31 to 51:

> "Note that E^*_s is now a function of coating thickness and material properties of the coating and the substrate. The essence of Eq. (8) is that ***the coated sample is equivalent to a homogenous virtual sample with a modified modulus depending on the dimensionless coating thickness***. When α is infinity (no substrate at all and θ is zero), it is evident that E^*_s in Eq. (8) equals E^*_c. In this case, the sample is solely composed of the coating material. ...
>
> ...in the case of zero α (no coating at all), one can find E^*_s in Eq. (8) equals E^*_b with the help of Eq. (9). Indeed, these two special cases are the two limiting cases mentioned above. (Emphasis added).

In Liu, E^*_s is the elastic (or Young's) modulus of the coated sample (i.e., the composite structure) (col. 2, lines 63-64), E^*_c is the elastic modulus of the coating (col. 2, line 65), and E^*_b is the elastic modulus of the base or substrate (col. 4, lines 10-11).

As such, Liu clearly verifies that for a wafer having a thin film coating applied thereon, the resulting elastic modulus of the composite structure is linearly related to the thickness of the coating applied to the wafer and the elastic modulus of both the coating and the wafer itself.

Experimental and analytical results showing that the same holds true for silicon carbide coatings are provided in "*Micromechanical properties of silicon-carbide thin films deposited using single-source chemical-vapor deposition*," by C. R. Stoldt et al. (Applied Physics Letters, Volume 79, Number 3, 16 July 2001, pp. 347-349), attached hereto as Appendix III. For example, Stoldt states, at page 348, col. 1, lines 32-42, that:

> *The elasticity of the deposited SiC coatings is characterized by examining the change in resonance frequency* of the coated cantilever as a function of deposition time (effectively, film thickness).... *It is readily observed that the resonance frequency increases in proportion to film thickness*, indicative of a uniformly deposited SiC film whose stiffness increases with thickness. (Emphasis added).

In Berthold, the bottom wafer comprises a 500 micrometer thick layer of Pyrex 7740 with a 200 nanometer (or 0.2 micrometer) thick layer of silicon carbide (having an elastic modulus of 430 GPa) deposited thereon. See Berthold, page 225, column 1, paragraph 2; and Office Action, page 4, table 2. As shown in "*MatWeb, The Online Materials Database,*" attached hereto as Appendix IV, the elastic modulus of Pyrex 7740 is 62.75 gigaPascals (GPa). Thus, applying a linear relationship, in accordance with the teachings of Roark and Young, and the experimental and analytical results of both Liu and Stoldt, the resulting effective elastic modulus of the bottom wafer for Berthold will be approximately $((500 \times 62.75)+(0.2 \times 430))/(500+0.2) \approx 62.9$ GPa. As such, the effective elastic modulus for the bottom wafer in Berthold is substantially lower than the "150 gigaPascals" requirement recited in Applicants' independent claim 1.

Applicants respectfully submit that Fukushima fails to cure these deficiencies of Berthold. Specifically, Fukushima appears to describe a method of manufacturing a hermetic seal package. Fukushima does not, however, teach or suggest anodically bonding "*a first layer comprising a glass*" directly to "*a first substrate having an elastic modulus greater than about 150 gigaPascals*," as recited in Applicants' independent claim 1. Applicants, therefore, respectfully submit that neither Berthold nor Fukushima, alone or in proper combination, teaches or suggests every element of Applicants' independent claim 1.

Because claims 2-3 and 5-11 depend, either directly or indirectly, from independent claim 1, and include all of the limitations thereof, Applicants respectfully submit that these claims are allowable as well. Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 1-3 and 5-11 under 35 U.S.C. §103(a) as being unpatentable over Berthold in view of Fukushima.

Claim 4 was rejected as unpatentable over Berthold and Fukushima, further in view of Sarro. Claim 12 was rejected over Berthold and Fukushima, further in view of Applicants disclosure (Paragraph [0026]). Claims 13, 14, and 15 were rejected over Berthold and Fukushima, further in view of the combined teachings of Wagner, Sarro, Schmidt, and Lee.

Each of these rejections relates to claims that depend from independent claim 1. Applicants respectfully submit, however, that none of the cited references, either alone or in proper combination, teaches or suggests anodically bonding "*a first layer comprising a glass*" directly to "*a first substrate having an elastic modulus greater than about 150 gigaPascals*," as recited in Applicants' independent claim 1. Accordingly, neither Wagner, Sarro, Schmidt, nor Lee cures the deficiencies of Berthold and Fukushima with respect to independent claim 1. Moreover, paragraph [0026] of Applicants' specification is not prior art to Applicants' independent claim 1. Thus, because claims 4 and 12-15 depend, either directly or indirectly from independent claim 1, and include all of the limitations thereof, Applicants respectfully submit that they are allowable as well. Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejections of claims 4 and 12-15 under 35 U.S.C. § 103(a).

Claim 16 was rejected over Berthold and Fukushima as applied to claim 1. However, as claim 16 incorporates all the limitations of Applicants' independent claim 1, it too is patentable over Berthold and Fukushima for at least the same reasons as discussed above with respect to Applicants' independent claim 1.

Finally, claim 17 was rejected over Berthold and Fukushima, further in view of Wagner, Sarro, Schmidt, and Lee.

Applicants' amended independent claim 17 recites "*a MEMS component comprising a glass layer*," "*a device package having an elastic modulus greater than about 150 gigaPascals, formed from polycrystalline silicon carbide*" and "*applying a voltage to form an effective anodic bond between the MEMS component and the package*." In contrast, Berthold merely describes using a thin film of silicon carbide (of 200 nm thickness) to bond together two glass wafers, and not a glass layer to the "*device package . . . formed from polycrystalline silicon carbide*," as recited in Applicants' amended independent claim 17. In addition, and as described above, the bottom layer of Berthold does not have "*an elastic modulus greater than about 150 gigaPascals*," but will rather have a significantly smaller elastic modulus due to the combination of a relatively thick glass wafer and a thin film of silicon carbide that is coated thereon.

Accordingly, Berthold also does not describe "*applying a voltage to form an effective anodic bond between the [glass] MEMS component and the [polycrystalline silicon carbide] package*," wherein the package has "*an elastic modulus greater than about 150 gigaPascals*," as recited in Applicants' amended independent claim 17.

Applicants respectfully submit that Fukushima, Wagner, Sarro, Schmidt, and Lee fail to cure the deficiencies of Berthold with respect to amended independent claim 17, at least because they fail to disclose or suggest "*a device package having an elastic modulus greater than about 150 gigaPascals, formed from polycrystalline silicon carbide*" and "*applying a voltage to form an effective anodic bond between the [glass] MEMS component and the [polycrystalline silicon* *carbide] package*." Applicants therefore submit that Berthold, Fukushima, Wagner, Sarro, Schmidt, and Lee, alone or in proper combination, fail to teach or suggest every element of Applicants amended independent claim 17.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejection of claim 17 under 35 U.S.C. §103(a).

New Claims 19-21

With this Amendment and Response, Applicants add new claims 19-21. Claims 19-21 depend directly from independent claim 1 and are respectfully submitted to be patentable for at least the same reasons as discussed above with respect to claim 1.

Accordingly, Applicants respectfully request the allowance of new claims 19-21 in due course.

CONCLUSION

Applicants respectfully submit that, in light of the foregoing amendments and remarks, all of the pending claims are in condition for allowance. Accordingly, the Applicants respectfully request reconsideration, withdrawal of all grounds of rejection, and the allowance of the pending claims in due course. If, in the Examiner's opinion, a telephonic interview would expedite the favorable prosecution of the present application, the undersigned attorney would welcome the opportunity to discuss any outstanding issues and to work with the Examiner toward placing the application in condition for allowance.

Respectfully submitted,

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